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SUMMARY PAGE

THE PROBLEM

Currently, the criterion for prediction of performance of student naval aviators is the dichotomy of success versus failure in undergraduate flight training. There is, however, a costly attrition problem with regard to those aviators who earn their wings but do not successfully complete the postgraduate, or replacement air group (RAG), phase of instruction. This study examined the potential of grades assigned in the undergraduate phase of training as predictors of success in the RAG.

FINDINGS

The multiple correlation coefficient between training grades and the criterion of success vs. failure in the RAG was found to be .433. These results were crossvalidated on an independent sample with a resultant correlation coefficient of .359 ($p < .001$). Actuarial data developed on the cross-validation sample indicated that had the proposed prediction equation been in effect, the attrition rate would have been reduced by 33.8 percent.

RECOMMENDATIONS

Predictor scores should be generated for each student upon completion of flight training in jet aircraft. Those students receiving predictor scores in the lower ranges (i.e., indicating a low probability of success in the RAG) should be considered for reassignment to a less difficult aircraft type. In addition, equations should be developed for the prediction of RAG success in the multi-engine and helicopter RAG's as well as the jets.

INTRODUCTION

Historically, the development of a criterion against which to measure proficiency at a complex task has been a much desired yet elusive goal. Attempts to fulfill this objective with respect to the performance of naval aviators upon completion of training have been difficult. Such a criterion is necessary in order to assess the effectiveness of the Naval Aviation Training Program. The major problem thus far has been the nature of the operational setting in which the naval aviator must function. A method has not yet been found to equate the characteristics and difficulty of missions across aircraft type in order to get a reliable and routinely applicable measure of pilot performance. The possibility of rating individuals within squadrons with respect to performance has also been explored (1 - 3). Though isolated efforts with this approach have been fruitful, typically, the personnel in question are reluctant to divulge information perceived to be detrimental to a fellow aviator.

Previous efforts at prediction have demonstrated the utility of a successive approach (4). This is due to the typically good relationship between factors occurring in temporal proximity. Figure 1 illustrates the major segments of naval aviation training leading to a fleet assignment. A man proceeds through the pre-flight, primary, basic, and advanced stages and is then designated as a naval aviator. The establishment of a fleet performance measure is the ultimate goal of aviation criterion development. However, at this time we are unable to obtain fleet performance data in a systematic fashion. Replacement air group (RAG) training is that transitional phase of a designated naval aviator's career in which he changes from training aircraft to operational aircraft and is prepared for a fleet assignment. Since the RAG phase is the last step to operational flying, application of the notion of successive relationships leads to the conclusion that RAG performance could serve as a useful interim criterion. It is currently possible to get RAG training data of a dichotomous success/fail nature for each assigned aviator. Therefore, it was concluded that RAG performance should be considered: 1) as a means of evaluating training effectiveness (i.e., criterion development), and 2) as a possible indicant of a pilot's performance in the fleet (i.e., prediction). This study investigated the relationship between performance in naval aviation training and in the replacement air groups.

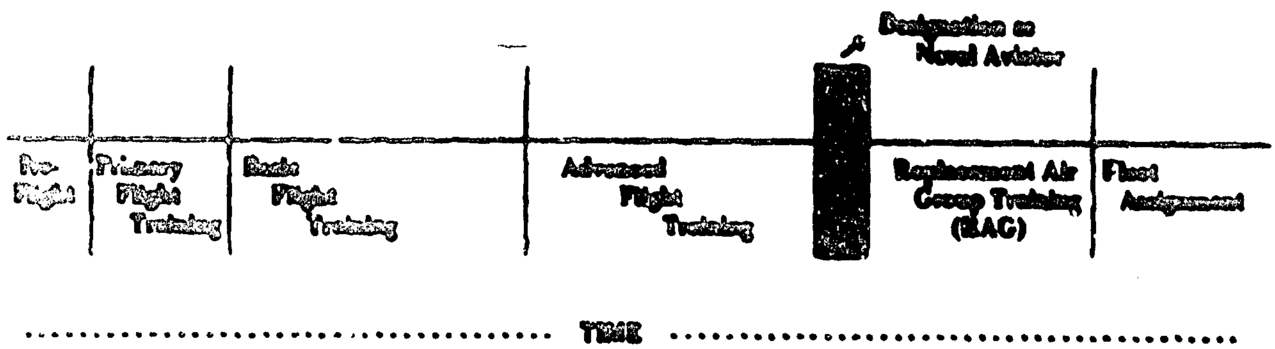

Figure 1

Flow of Naval Aviation Training

PROCEDURE

SUBJECTS

The sample group for this study included 592 designated naval aviators, 218 of whom were assigned to replacement air group training in east coast squadrons and 374 assigned to the west coast, during the period of November 1966 to November 1967. Excluded from consideration were those aviators who were dropped from training for medical reasons, personal hardship, disciplinary action, or death.

DATA ANALYSIS

For purposes of crossvalidation the total sample was divided into two subgroups. This grouping corresponded to the existing division of the east and west coast. The sample was divided in this way to provide a more conservative measure of crossvalidation. If both had been randomly divided, the subsamples may have had a greater degree of homogeneity and thus result in a less conservative approach to crossvalidation. In addition, such a division facilitated handling of the data.

A multiple correlation analysis was conducted on the west coast sample in order to identify the Training Command variables that best functioned as predictors of the RAG criterion. Thirty-three training grades were considered against the dichotomy of success versus failure in the RAG phase. The means, standard deviations, and zero-order correlations of each variable with the criterion are listed in Appendix A.

The selected prediction variables and their respective weights were used to generate regression scores (predictor scores) for the east coast sample. These data, correlated with the criterion, served as an index of crossvalidation.

In addition to the calculation of the cross-validation coefficient, the east coast predictor scores were utilized to demonstrate the potential of a practical application of the initial findings. Separate frequency distributions of predictor scores of the successful and unsuccessful aviators were compiled. This technique allowed for a determination of the proportion of completes and attrites at or below a given score. By this means it was possible to identify an optimal cut-off score that would screen out the maximum number of potential failures at the cost of a minimum number of completes. The hypothetical reduction in the east coast attrition rate was then computed.

RESULTS AND DISCUSSION

The over-all attrition rate for the combined east and west coast sample of 592 aviators was 13 percent. The east coast squadrons lost 13.3 percent of their initial input and the west coast group lost 12.8 percent.

The multiple correlation analysis of the west coast data resulted in the selection of 15 variables as predictors of RAG success. As expected, the advanced training phase grades accounted for most of the predicted variance. The multiple correlation coefficient (corrected for shrinkage) was .433. These data are summarized in Table I.

Table I

Summary of Multiple Correlation Analysis for West Coast Replacement Air Groups

Selected Variables	Phase of Training	Cumulative Shrunken R
Air to Air Weapons	Advanced	302
Air to Ground Weapons	Advanced	.342
Basic Ground	Basic	.361
Physiology	Pre-flight	.378
Instrument Navigation	Advanced	.389
Basic Instruments	Advanced	.401
Navigation	Pre-flight	.407
Pre Solo	Primary	.412
Precision	Primary	.417
Mechanical Comprehension Test	Selection	.422
Biographical Inventory	Selection	.424
Precision/Aerobatics	Basic	.426
Math Exemption Test	Pre-flight	.429
Basic Instruments	Basic	.432
Advanced Ground	Advanced	.433

Predictor scores were generated for each subject in the east coast sample by the regression equation derived from analysis of the west coast sample. The selected variables and weights used in the predictor equation are noted in Appendix B. The point bi-serial correlation coefficient between these regression scores and the success/failure criterion was .359 ($p < .001$). These results served as an index of how the equation would predict for an independent sample from the same population.

To make the results more meaningful, a hypothetical implementation of the findings was conducted for the east coast sample. Frequency distributions of predictor scores were compiled for the 159 successful and 29 unsuccessful aviators. This approach allowed for examination of the percentage of completes and the percentage of failures at or below any given predictor score. The idea was to identify that score below which there would be the maximum number of failures and a minimum of successes. An abridged summary of these data is shown in Table II. Had a predictor score of 760 been utilized as a cutting point, 41.4 percent of the unsuccessful aviators would have been screened prior to commencement of the jet RAG training. The false positives would have amounted to 6.9 percent of the successful aviators.

Table II

Percentage of Successful and Unsuccessful RAG Aviators Below a Given Predictor Score

Predictor Score	% Unsuccessful at or Below Predictor Score	% Successful at or Below Predictor Score
550	3.4	0.5
655	10.3	2.1
760	41.4	6.9
850	65.5	19.0
955	79.0	33.8
1060	89.7	60.8
1150	93.1	81.5
1210	100.0	89.9

N Successful = 189
N Unsuccessful = 29

Under the existing system the east coast jet RAG's suffered a 13.3 percent attrition rate. Had the predictor score approach been utilized, the input would have been reduced by 11.5 percent, but the attrition rate would have dropped from 13.3 percent to 8.8 percent or an effective reduction of 33.8 percent of the original attrition rate.

CONCLUSION

The attrition rates of the two jet RAG's indicate that some system is necessary to reduce this costly problem. Typically, the cost of the 6-month RAG training is equal to that of the entire 18-month syllabus prior to designation as a naval aviator. Since most of the attrition in the study occurred late in RAG training, the cost per failure was substantial.

The methodology discussed above may serve as a partial solution to the RAG attrition problem. By appropriately weighting Training Command grades found to be predictive of RAG performance, a newly designated aviator could be screened one final time prior to assignment. If his predictor were so low as to warrant a low probability of success in a given type of RAG training, he could be reassigned to another perhaps less difficult aircraft type in which he would have a more favorable likelihood of completion.

The fact that it is possible to predict success for a group of aviators that had previously been so carefully selected is encouraging. The next logical step is to expand the RAG criterion to a continuous type of performance measure rather than the current dichotomy of success versus failure. Given such a measure, coupled with the rationale of the successive approach to prediction of fleet performance, another goal could be served by the technique discussed above; that is, the Naval Air Training Command would be able to identify those aspects of training most relevant to success in the RAG and hence the fleet. This system could provide the feedback that is necessary for monitoring syllabus effectiveness.

This study serves as a step toward narrowing the gap in the development of a fleet criterion. The approach discussed above combined with a standardized RAG grading system and a systematic technique of evaluating fleet performance such as that discussed by Boyles et al. (2) can operate to solve the criterion problem in military aviation.

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Appendix A

Means, Standard Deviations, and Zero-order Correlations with the Criterion of the Training Grades Examined as Potential Predictors (West Coast Sample)

Variable	Mean	S. D.	r_{pbi}
Aviation Qualification Test	86.034	13.927	-.029
Mechanical Comprehension Test	62.797	6.929	-.065
Spatial Apperception Test	21.395	5.649	-.043
Biographical Inventory	40.328	12.295	.049
Math Exemption Test	53.606	9.937	.047
Physics Exemption Test	53.360	10.721	.013
Aerodynamics	53.877	9.059	.004
Navigation	54.223	6.953	.036
Engineering	54.777	8.171	-.044
Physiology	55.289	9.191	.062
Physical Training	54.160	5.688	.016
Pre Solo	3.070	.105	-.064
Precision	3.095	.092	.081
Transition	3.003	.076	-.006
Precision/Acrobatics	3.010	.084	.095
Basic Instruments (Basic)	3.057	.104	.012
Night Flying	3.061	.162	.061
Radio Instruments	3.040	.100	.033
Formation	3.010	.072	.127*
Carrier Qualification (Basic)	3.030	.090	.071
Basic Ground	52.477	5.280	-.081
Advanced Ground	51.948	5.937	-.025
Transition	3.033	.059	.138**
Basic Instruments (Advanced)	3.068	.055	.033
Instrument Navigation	3.003	.049	.179**
Advanced Familiarization	3.016	.062	.062
Formation/Tactics	3.044	.051	.110*
Night Familiarization	3.041	.081	.046
Operations/Navigation	3.045	.067	.100
Air to Ground Weapons	3.055	.053	.265**
Tactics	3.039	.073	.163**
Air to Air Weapons	3.016	.058	.306**
Carrier Qualification (Advanced)	2.975	.254	.006

** Significant beyond .01 level.
* Significant beyond .05 level.

Appendix B

Selected Variables and Weights Used in the Computation of Predictor Scores*

Predictor Variable	Stage in Training	Weight**
Air to Air Weapons	Advanced	1333
Air to Ground Weapons	Advanced	1215
Basic Ground	Basic	- 11
Physiology	Pre-Flight	6
Instrument Navigation	Advanced	11[illegible]
Basic Instruments	Advanced	- 70.4
Navigation	Pre-Flight	5
Pre-Solo	Primary	- 428
Precision	Primary	360
Mechanical Comprehension Test	Selection	- 7
Biographical Inventory	Selection	2
Precision/Acrobatics	Basic	400
Math Exemption Test	Pre-Flight	3
Basic Instruments	Basic	- 23.5
Advanced Ground	Advanced	- 4
	Constant	-7811

* Predictor scores are calculated as follows: The constant is added to the sum of the products of the scores on each predictor variable and its respective weight. The constant was included in order to set the mean predictor score at 1000.

** These weights are rounded whole number versions of those actually assigned to each variable by the multiple correlation formula. The weights were "wholed" and rounded off in order facilitate computation and interpretation.

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13. ABSTRACT

The current criterion for prediction of performance of student naval aviators is the dichotomy of success versus failure in undergraduate flight training. This criterion has enabled the Naval Air Training Command to make reasonable estimates of the probability of an applicant or student completing flight training. However, a costly attrition problem exists among those aviators who completed undergraduate flight training but were not successful in the replacement air group (RAG), or post-graduate phase of instruction. This study employed a multiple correlation analysis to examine the possibility of utilizing RAG completion as an advanced criterion variable. Undergraduate training grades were found to significantly predict RAG completion. These findings were cross-validated on an equivalent sample. Had the proposed weighting system been employed, the attrition rate of the cross-validation sample would have been reduced by [illegible] percent.

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